New Hampshire Volunteer River Assessment Program
2005 Hodgson Brook Watershed Water Quality Report

Photo: Hodgson Brook (00M-HOB), Cate Street Bridge, Portsmouth

Prepared by:

State of New Hampshire
Department of Environmental Services
Water Division
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New Hampshire Volunteer River Assessment Program
2005 Hodgson Brook Watershed Water Quality Report

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ACKNOWLEDGEMENTS

The New Hampshire Department of Environmental Services (NHDES) -Volunteer River Assessment Program (VRAP) extends sincere thanks to the Hodgson Brook Watershed Advisory Board for their efforts during 2005. This report was created solely from the data collected by staff of the Hodgson Brook Restoration Project and NHDES listed below. Their time and dedication is an expression of their genuine concern for local water resources and has significantly contributed to our knowledge of river and stream water quality in New Hampshire.

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1. INTRODUCTION

1.1. Purpose of Report

Each year the VRAP prepares and distributes a water quality report for each volunteer group that is based solely on the water quality data collected by that volunteer group during a specific year. The reports summarize and interpret the data, particularly as they relate to New Hampshire surface water quality standards, and serve as a teaching tool and guidance document for future monitoring activities by the individual volunteer groups.

1.2. Report Format

Each report includes the following:

- **Volunteer River Assessment Program (VRAP) Overview**

  This section includes a discussion of the history of VRAP, the technical support, training and guidance provided by NHDES, and how data is transmitted to the volunteers and used in surface water quality assessments.

- **Monitoring Program Description**

  This section provides a description of the volunteer group's monitoring program including monitoring objectives as well as a table and map showing sample station locations.

- **Results and Discussion**

  Water quality data collected during the year are summarized on a parameter-by-parameter basis using (1) a summary table that includes the number of samples collected, data ranges, the number of samples meeting New Hampshire water quality standards, and the number of samples adequate for water quality assessments at each station, (2) a discussion of the data, (3) a list of applicable recommendations, and (4) a river graph showing the range of measured values at each station. Sample results reported as less than the detection limit were assumed equal to one-half the detection limit on the river graphs. This approach simplifies the understanding of the parameter of interest, and specifically helps one to visualize how the river or watershed is functioning from upstream to downstream. In addition, this format allows the reader to better understand potential pollution areas and target those areas for additional sampling or environmental enhancements. Where applicable, the river graph also shows New Hampshire surface water quality standards or levels of concern for comparison purposes.

- **Appendix A – Data**

  This appendix includes a spreadsheet showing the data results and additional information, such data results which do not meet New Hampshire surface water quality standards, and data that is unusable for assessment purposes due to quality control requirements.

- **Appendix B – Interpreting VRAP Water Quality Parameters**

  This appendix includes a brief description of water quality parameters typically sampled by VRAP volunteers and their importance, as well as applicable state water quality criteria or levels of concern.

- **Appendix C – Glossary of River Ecology Terms**

  This appendix contains a list of terms commonly used when discussing river ecology and water quality.

2. PROGRAM OVERVIEW

2.1. Past, Present, and Future

In 1998, the New Hampshire Department of Environmental Services (NHDES) initiated the New Hampshire Volunteer River Assessment Program (VRAP) as a means of expanding public education of water resources in New Hampshire. VRAP promotes awareness and education of the importance of maintaining water quality in rivers and streams. VRAP was created in the wake of the success of the existing New Hampshire Volunteer Lake Assessment Program (VLAP), which provides educational and stewardship opportunities pertaining to lakes and ponds to New Hampshire's residents.

Today, VRAP continues to serve the public by providing water quality monitoring equipment, technical support, and educational programs. In 2005, VRAP supported twenty-eight volunteer groups on numerous rivers and watersheds throughout the state. These volunteer groups conduct water quality monitoring on an ongoing basis. The work of the VRAP volunteers increases the amount of river water quality information available to local, state and federal governments, which allows for effective financial resource allocation and watershed planning.

2.2. Technical Support

VRAP lends and maintains water quality monitoring kits for volunteer groups throughout the state. The kits contain electronic meters and supplies for "in-the-field" measurements of water temperature, dissolved oxygen, pH, specific conductance (conductivity), and turbidity. These are the core parameters typically measured by volunteers. However, other water quality parameters such as nutrients, metals, and *E. coli* can also be studied by volunteer groups, although VRAP does not always provide funds to cover laboratory analysis costs. Thus, VRAP encourages volunteer groups to pursue other fundraising activities such as association membership fees, special events, in-kind services (non-monetary contributions from individuals and organizations), and grant writing.

VRAP typically recommends sampling every other week during the summer, and volunteer groups are encouraged to organize a long-term sampling program in order to begin to determine trends in river conditions. Each year volunteers design and arrange a sampling schedule in cooperation with NHDES staff. Project designs are created through a review and discussion of existing water quality information, such as known and perceived problem areas or locations of exceptional water quality. The interests, priorities, and resources of the partnership determine monitoring locations, parameters, and frequency.

Water quality measurements repeated over time create a picture of the fluctuating conditions in rivers and streams and help to determine where improvements, restoration or preservation may benefit the river and the communities it supports. Water quality results are also used to determine if a river is meeting surface water quality standards. Volunteer monitoring results, meeting DES Quality Assurance and Quality Control (QA/QC) requirements, supplement the efforts of DES to assess the condition of New Hampshire surface waters. The New Hampshire Surface Water Quality Regulations are available through the DES Public Information Center at www.des.state.nh.us/wmb/Env-Ws1700.pdf or (603) 271-1975.

2.3. Training and Guidance

Each VRAP volunteer attends an annual training session to receive a demonstration of monitoring protocols and sampling techniques. Training sessions are an opportunity for volunteers to receive an updated version of monitoring techniques. During the training, volunteers have an opportunity for hand-on use of the VRAP equipment and may also receive instruction in the collection of samples for laboratory analysis. Training is accomplished in approximately two hours, after which volunteers are certified in the care, calibration, and use of the VRAP equipment. In some cases, veteran group coordinators can attend a “train the trainer” session. In these trainings the group coordinator receives an update in sampling protocols and techniques and will then train the individual volunteers of their respective group.

VRAP groups conduct sampling according to a prearranged monitoring schedule and VRAP protocols. NHDES staff from the VRAP program aim to visit each group annually during a scheduled sampling events to verify that volunteers successfully follow the VRAP protocols. If necessary, volunteers are re-trained during the visit, and the group’s monitoring coordinator is notified of the result of the verification visit. VRAP groups forward water quality results to NHDES for incorporation into an annual report and state water quality assessment activities.

2.4. Data Usage

2.4.1. Annual Water Quality Reports

All data collected by volunteers are summarized in water quality reports that are prepared and distributed after the conclusion of the sampling period (typically fall or winter). Each volunteer group receives copies of the report. The volunteers can use the reports and data as a means of understanding the details of water quality, guiding future sampling efforts, or determining restoration activities.

2.4.2. New Hampshire Surface Water Quality Assessments

Along with data collected from other water quality programs, specifically the State Ambient River Monitoring Program, applicable volunteer data are used to support periodic DES surface water quality assessments. VRAP data are entered into NHDES’s Environmental Monitoring Database and are ultimately uploaded to the Environmental Protection Agency’s database, STORET.

Assessment results and the methodology used to assess surface waters are published by DES every two years (i.e., Section 305(b) Water Quality Reports) as required by the federal Clean Water Act. The reader is encouraged to log on to the DES web page to review the assessment methodology and list of impaired waters http://www.des.state.nh.us/wmb/swqa/.

2.5. Quality Assurance/Quality Control

In order for VRAP data to be used in the assessment of New Hampshire's surface waters, the data must meet quality control guidelines as outlined in the VRAP Quality Assurance Project Plan (QAPP). The VRAP QAPP was approved by NHDES and reviewed by EPA in the summer of 2003. The QAPP is reviewed annually and is officially updated and approved every five years. The VRAP Quality Assurance/Quality Control (QA/QC) measures include a six-step approach to ensuring the accuracy of the equipment and consistency in sampling efforts.

- **Calibration**: Prior to each measurement, the pH and dissolved oxygen meters are calibrated. Conductivity and turbidity meters are calibrated and/or checked against a known standard before the first measurement and after the last one.
- **Replicate Analysis**: A second measurement by each meter is taken from the original sample at one of the stations during the sampling day. The replicate analysis should not be conducted at the same station over and over again, but should be conducted at different stations throughout the monitoring season.
- **6.0 pH Standard**: A reading of the pH 6.0 buffer is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the 6.0 pH standard check should be conducted at different stations.
- **Zero Oxygen Standard**: A reading of a zero oxygen solution is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the zero oxygen standard check should be conducted at different stations.
- **DI Turbidity Blank**: A reading of the DI blank is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the blank check should be conducted at different stations.
- **Post-Calibration**: At the conclusion of each sampling day, all meters are calibrated.

2.5.1. Measurement Performance Criteria

Precision is calculated for field and laboratory measurements through measurement replicates (instrumental variability) and is calculated for each sampling day. The use of VRAP data for assessment purposes is contingent on compliance with a parameter-specific relative percent difference (RPD) as derived from equation 1, below. Any data exceeding the limits of the individual measures are disqualified from surface water quality assessments. All data that exceeds the limits defined by the VRAP QAPP are acknowledged in the data tables with an explanation of why the data was unusable. Table 1 shows typical parameters studied under VRAP and the associated quality control procedures.

(Equation 1)

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\ \%$$

where x_1 is the original sample and x_2 is the replicate sample

Table 1. Field Analytical Quality Controls

Water Quality Parameter	QC Check	QC Acceptance Limit	Corrective Action	Person Responsible for Corrective Action	Data Quality Indicator
Temperature	Measurement replicate	± 0.2 °C	Repeat measurement	Volunteer Monitors	Precision
Dissolved Oxygen	Measurement replicate	± 2% of saturation, or ± 0.2 mg/L	Recalibrate instrument, repeat measurement	Volunteer Monitors	Precision
	Known buffer (zero O_2 solution)	<0.5 mg/L	Recalibrate instrument, repeat measurement	Volunteer Monitors	Relative accuracy
pH	Measurement replicate	± 0.1 std units	Recalibrate instrument, repeat measurement	Volunteer Monitors	Precision
	Known buffer (pH = 6.0)	± 0.1 standard units	Recalibrate instrument repeat measurement	Volunteer Monitors	Accuracy
Specific Conductance	Measurement replicate	± 30 µS/cm	Recalibrate instrument, repeat measurement	Volunteer Monitors	Precision
	Method blank (Zero air reading)	± 5.0 µS/cm	Recalibrate instrument, repeat measurement	Volunteer Monitors	Accuracy
Turbidity	Measurement replicate	± 0.1 NTU	Recalibrate instrument, repeat measurement	Volunteer Monitors	Precision
	Method blank (DI Water)	± 0.1 NTU	Recalibrate instrument, repeat measurement	Volunteer Monitors	Accuracy

3. METHODS

During the summer of 2005, the Hodgson Brook Watershed Advisory Board began water quality monitoring in the Hodgson Brook watershed. The goal of this effort was to provide water quality data from the Hodgson Brook watershed relative to surface water quality standards and to allow for the assessment of the waterbodies monitored for support of aquatic life and primary contact recreation. The establishment of a long-term monitoring program will allow for an understanding of the river's dynamics, or variations on a station-by-station and year-to-year basis. The data can also serve as a baseline from which to determine any water pollution problems in the river and/or watershed. The Volunteer River Assessment Program has provided field training, equipment, financial assistance for laboratory costs, and technical assistance.

The Hodgson Brook watershed water quality monitoring program is one part of the larger Hodgson Brook Restoration project began in response to concerns expressed by local residents, city officials, and businesses. In 2001, the Advocates for North Mill Pond (ANMP), a group of citizens working to protect North Mill Pond, was awarded a grant from NHDES to study Hodgson Brook and develop a restoration plan. The ANMP put together the Hodgson Brook Watershed Advisory Board to help develop and implement the restoration plan. The ANMP and Hodgson Brook Watershed Advisory Board are working together to create a restoration plan that can be implemented at the local level by citizens and others concerned about the brook's health. The water quality data analyzed in this report is intended to assist the Hodgson Brook Watershed Advisory Board along with local, state and federal governments in restoration efforts, effective financial resource allocation, and watershed planning.

During 2005, trained volunteers and staff from the Hodgson Brook Watershed Advisory Board monitored water quality at eight stations in the Hodgson Brook Watershed (Figure 1, Table 2). Three stations in the Hodgson Brook watershed were monitored by NHDES using submersible dataloggers.

Station IDs are designated using a three letter code to identify the waterbody name plus a number indicating the relative position of the station. The higher the station number the more upstream the station is in the watershed. The entire Hodgson Brook watershed is designated as Class B waters.

Water quality monitoring was conducted from May to October. In-situ measurements of water temperature, air temperature, dissolved oxygen, pH, turbidity and specific conductance were taken using handheld meters provided by NHDES. Samples for *E.coli* and chloride were taken using bottles supplied by the NHDES laboratory and were stored on ice during transport from the field to the lab. Table 3 summarizes the parameters measured, laboratory standard methods, and equipment used.

Table 2. Sampling Stations for the Hodgson Brook Watershed, NHDES VRAP, 2005

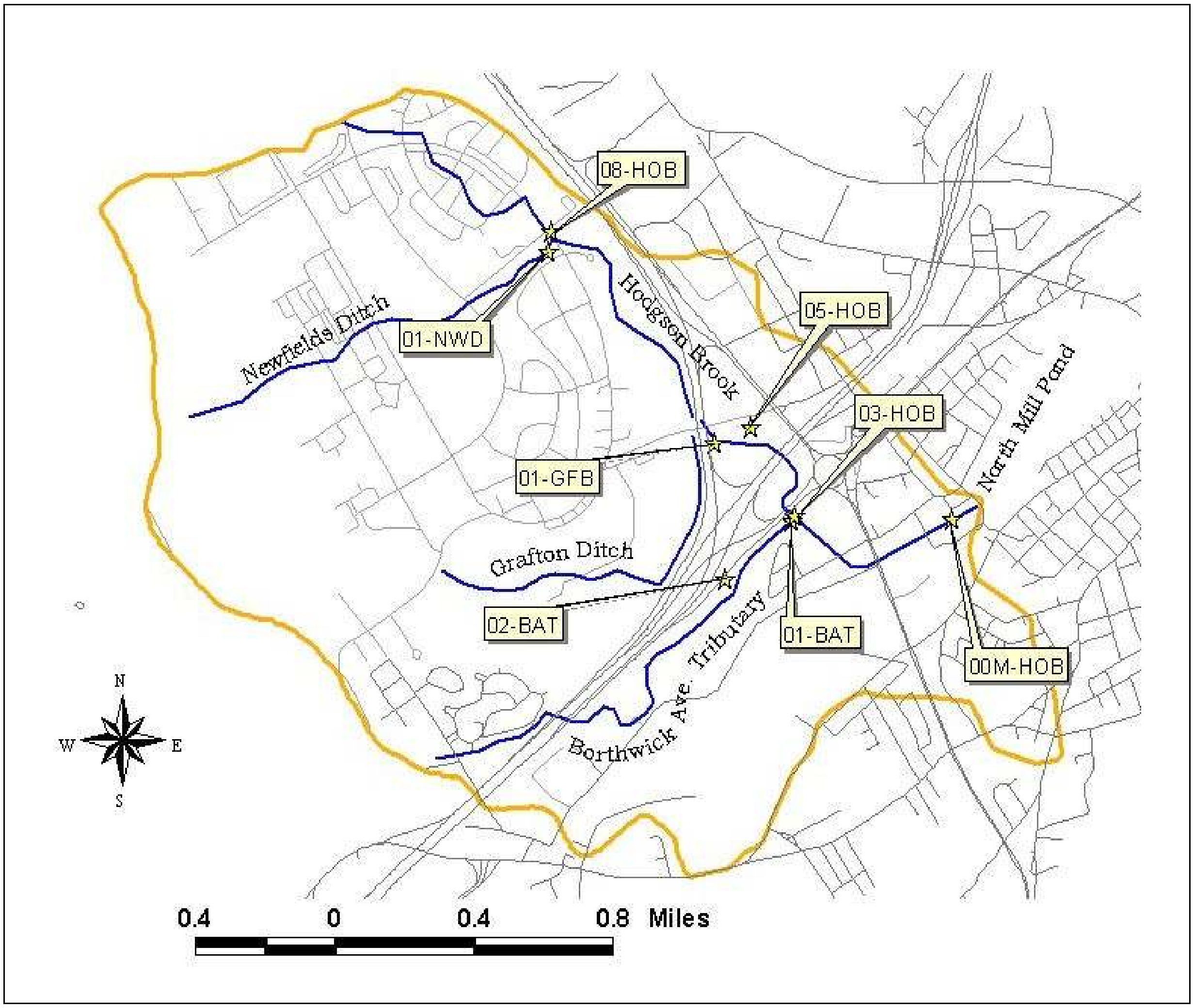
Station ID	Waterbody Name	Location	Town	Elevation*(Ft.)
08-HOB	Hodgson Brook	Intersection of Rye Street and Corporate Drive	Portsmouth	0
01-NWD	Newfields Ditch	Downstream of Confluence w/ Hodgson Brook	Portsmouth	0
05-HOB	Hodgson Brook	Northwood Road Culvert	Portsmouth	0
01-GFB	Grafton Brook	Culvert at I-95 On Ramp	Portsmouth	0
03-HOB	Hodgson Brook	Upstream of Borthwick Avenue Tributary	Portsmouth	0
02-BAT	Borthwick Avenue Tributary	Upper Station	Portsmouth	0
01-BAT	Borthwick Avenue Tributary	Lower Station	Portsmouth	0
00M-HOB	Hodgson Brook	Cate Street Bridge	Portsmouth	0

*Elevations have been rounded off to 100-foot increments for calibration of dissolved oxygen meter

Table 3. Sampling and Analysis Methods

Parameter	Sample Type	Standard Method	Equipment Used	Laboratory
Temperature	In-Situ	SM 2550	YSI 95	------
	Datalogger	SM 2550	YSI XLM 6000	------
Dissolved Oxygen	In-Situ	SM 4500 O G	YSI 95	------
	Datalogger	SM 4500 O G	YSI XLM 6000	------
pH	In-Situ	SM 4500 H+	Orion 210A+	------
	Datalogger	SM 4500 H+	YSI XLM 6000	------
Turbidity	In-Situ	EPA 180.1	Lamotte 2020	------
Specific Conductance	In-Situ	SM 2510	YSI 30	------
	Datalogger	SM 2510	YSI XLM 6000	------
E.coli	Bottle (Sterile)	SM 19 9213 D.3	------	NHDES
Chloride	Bottle	EPA 325.2	------	NHDES

Figure 1. Hodgson Brook Watershed and Monitoring Stations 2005



4. RESULTS AND DISCUSSION

4.1. Dissolved Oxygen

Between two and six measurements were taken in the field for dissolved oxygen concentration at eight stations in the Hodgson Brook watershed (Table 4). Of the 36 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency. VRAP staff also deployed submersible dataloggers to record dissolved oxygen at three stations in the Hodgson Brook watershed.

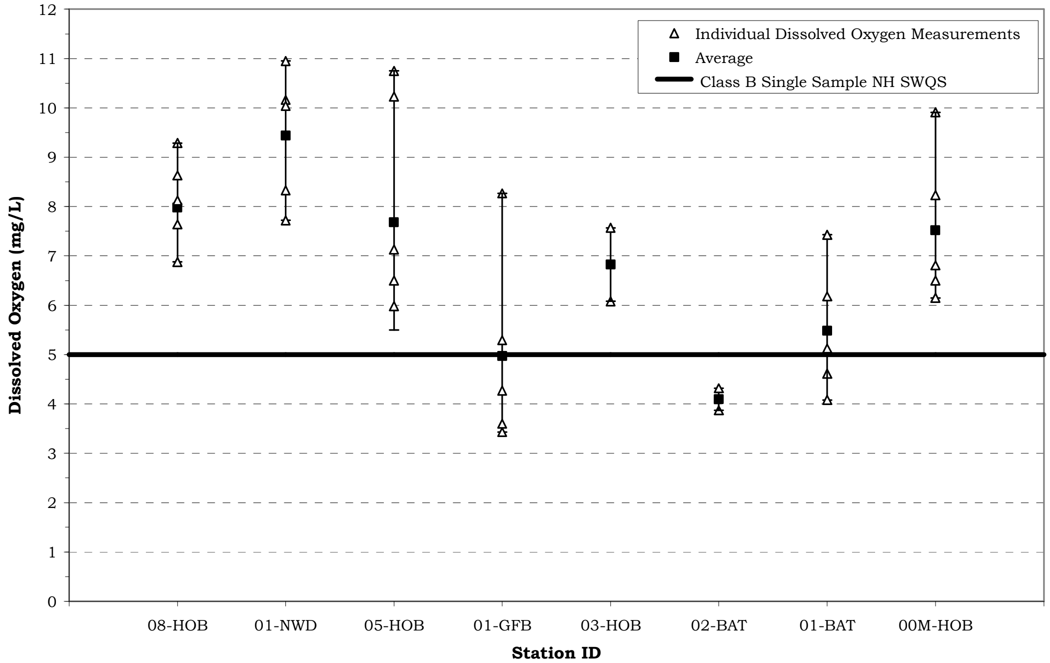
The Class B New Hampshire surface water quality standard for dissolved oxygen includes a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % of saturation. In other words, there are criteria for both concentration and saturation that must be met before the river can be assessed as meeting dissolved oxygen standards. Table 4 reports only dissolved oxygen concentration as more detailed analysis is required to determine if instantaneous dissolved oxygen saturation measurements are above or below water quality standards.

Table 4. Dissolved Oxygen (mg/L) Data Summary – Hodgson Brook Watershed, 2005

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
08-HOB	6	6.88 - 9.29	0	6
01-NWD	5	7.72 - 10.95	0	5
05-HOB	6	5.50 - 10.75	0	6
01-GFB	5	3.43 - 8.27	3	5
03-HOB	2	6.08 - 7.57	0	2
02-BAT	2	3.87 - 4.32	2	2
01-BAT	5	4.08 - 7.43	2	5
00M-HOB	5	6.15 - 9.91	0	5
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**36**

Dissolved oxygen concentration levels were variable with the average ranging from 4.1 mg/L to 9.4 mg/L (Figure 2). Stations 01-GFB, 02-BAT and 01-BAT had dissolved oxygen levels that were below state standards on multiple occasions. All other stations had dissolved oxygen levels above the standard on all occasions. Levels of dissolved oxygen sustained above the standards are considered adequate for the support of aquatic life and other desirable water quality conditions. Stations where the instantaneous dissolved oxygen standard was not met could potentially have a dissolved oxygen problem and further investigation is warranted. Low dissolved oxygen levels can be the result of natural conditions (e.g., the presence of wetlands or stagnant water caused by a beaver dam).

Figure 2. Dissolved Oxygen Statistics for the Hodgson Brook Watershed
May 22 - October 7, 2005, NHDES VRAP



Figures 3 and 4 show the results of dissolved oxygen concentration and saturation levels obtained at three stations in the Hodgson Brook watershed using submersible dataloggers. The meters were programmed to take dissolved oxygen readings every 15 minutes. Data from these meters is generally analyzed in 24 hour sections. During this deployment five full 24-hour periods were measured.

It should be noted that during this datalogger deployment a heavy amount of precipitation fell in the Portsmouth area and many rivers and streams in the Seacoast area, including Hodgson Brook, reached at or near their flood stage. According to the National Weather Service, 6.5 inches of rain fell in Portsmouth in the three day period from October 8^{th} – 10^{th}.

Stations 08-HOB and 01-BAT had daily averages of dissolved oxygen % saturation below the Class B standard of 75% on all five days and dissolved oxygen concentration levels below the standard on multiple days. Station 05-HOB had a daily average of dissolved oxygen % saturation above the standard on four days and below on one. Dissolved oxygen concentration levels were above the standard on all occasion at station 05-HOB.

Figures 3 and 4 also depict the typical cyclical variations in dissolved oxygen measurements one would expect to see during a 24-hour period in the summer. In general, dissolved oxygen levels are lowest in the early morning when there is low photosynthetic activity and a peak in respiration from organisms throughout the water column. This is the time of least oxygen production and greatest carbon dioxide emission. Peak dissolved oxygen levels occur when photosynthetic activity is at its peak. The greater the amount of photosynthetic activity the greater the production of oxygen as a byproduct of photosynthesis.

From October 5th – 7th day and night levels of dissolved oxygen levels at station 05-HOB varied significantly. The type and amount of plants and algae present in a waterbody can significantly impact dissolved oxygen levels. If many plants are present, the water can become supersaturated with dissolved oxygen during the day as photosynthesis occurs. Dissolved oxygen levels can then decrease significantly during the night when respiration is at its peak. The large daytime/nighttime swing in dissolved oxygen levels at 05-HOB indicates a high presence of plants and/or algae in this section of Hodgson Brook.

The type and density of riparian vegetation can also have a significant impact on dissolved oxygen levels. A lack of riparian vegetation will allow the surface water to receive more direct sunlight. This can increase the growth rate of aquatic plants thus leading to a higher rate of photosynthetic activity and respiration. The lack of riparian cover at station 05-HOB is likely contributing to the large variation in dissolved oxygen levels.

Figure 3. Dissolved Oxygen Saturation Statistics for the Hodgdon Brook Watershed October 5 - 11, 2005, NHDES VRAP

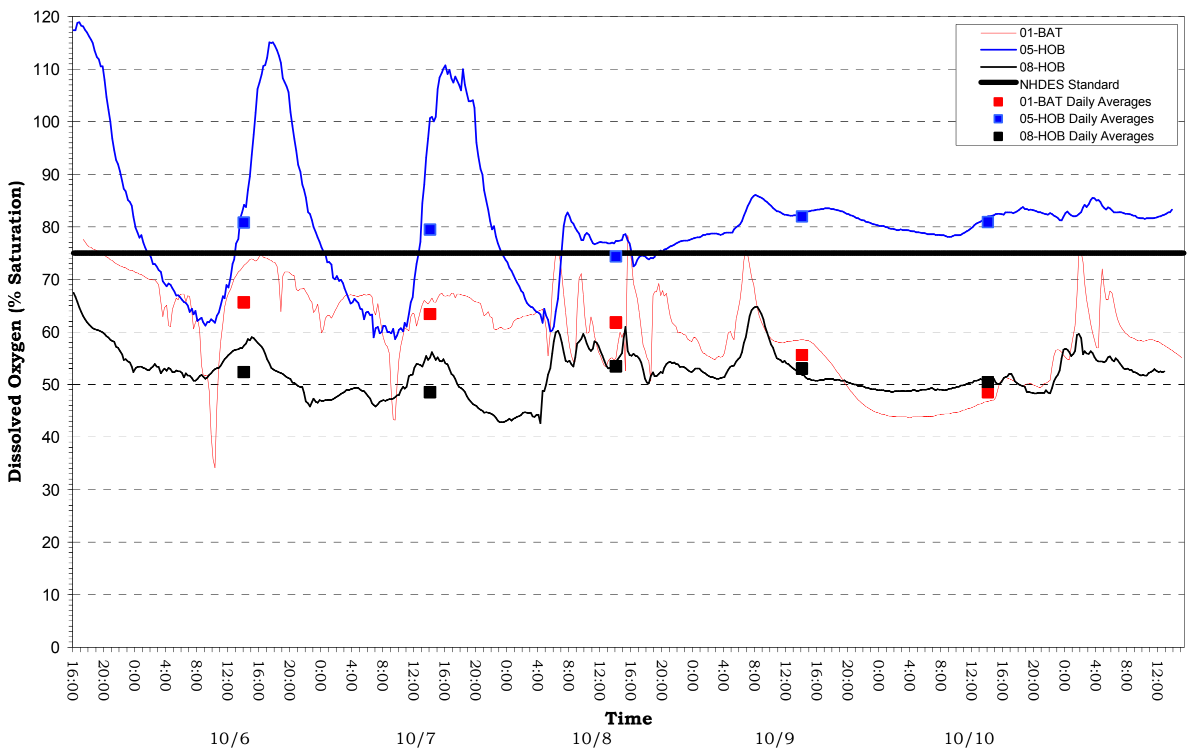
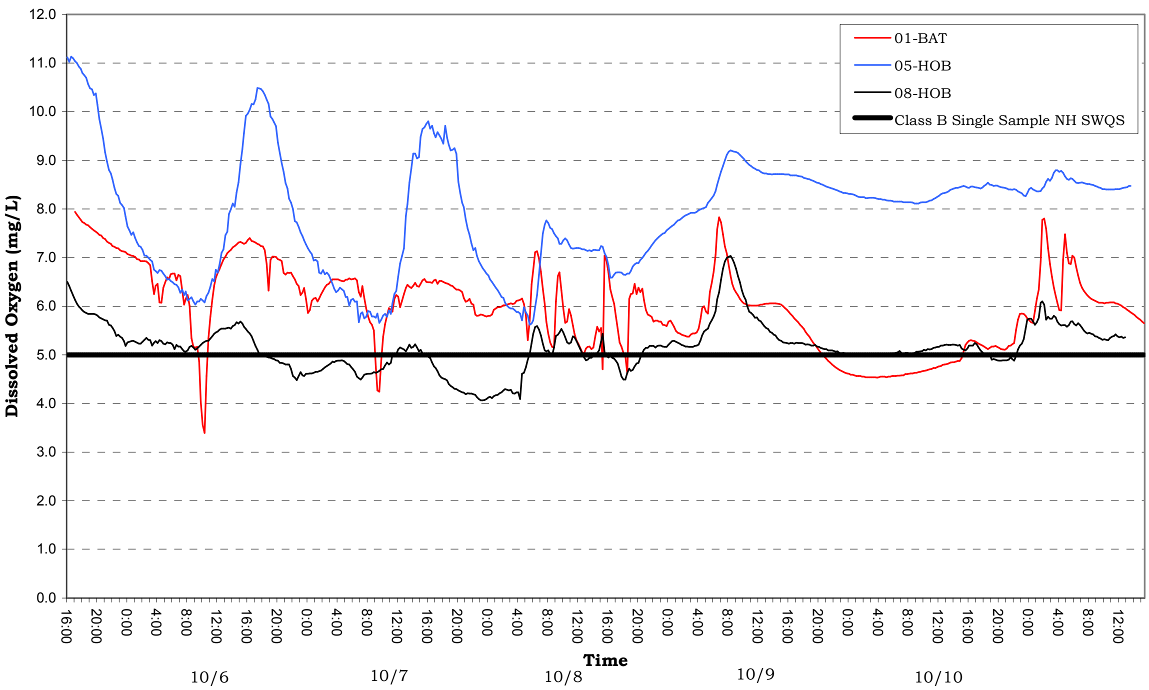


Figure 4. Dissolved Oxygen Concentration Statistics for the Hodgdon Brook Watershed October 5 - 11, 2005, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on. Further investigation is recommended at those stations with dissolved oxygen levels below the standard to determine if the lower dissolved oxygen levels are natural or due to other causes.

- The significant variation in dissolved oxygen levels at station 05-HOB is lively due to high levels of photosynthesis and respiration. One factor that can significantly impact plant levels is nutrient concentrations. Consider sampling for total phosphorous and/or nitrates to see what impact nutrient levels may be having.

- If possible, take measurements between 5:00 a.m. and 10:00 a.m., which is when dissolved oxygen is usually the lowest, and between 2:00 p.m. and 7:00 p.m. when dissolved oxygen is usually the highest.

- Continue to incorporate the use of in-situ dataloggers to automatically record dissolved oxygen saturation levels during a period of several days. The use of these instruments is dependent upon availability, and requires coordination with NHDES.

4.2. pH

Between two and six measurements were taken in the field for pH at eight stations in the Hodgson Brook watershed [Table 5]. Of the 36 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency. VRAP staff also deployed submersible dataloggers to record pH at three stations in the Hodgson Brook watershed.

The Class B New Hampshire surface water quality standard is 6.5 - 8.0, unless naturally occurring.

Table 5. pH Data Summary – Hodgson Brook Watershed, 2005

Station ID	Samples Collected	Data Range (standard units)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
08-HOB	6	7.2 - 7.51	0	6
01-NWD	5	7.33 - 8.00	0	5
05-HOB	6	7.22 - 7.52	0	6
01-GFB	5	6.89 - 7.15	0	5
03-HOB	2	7.21 - 7.46	0	2
02-BAT	2	7.00 - 7.07	0	2
01-BAT	5	6.94 - 7.19	0	5
00M-HOB	5	7.39 - 7.79	0	5
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**36**

All stations on all occasions had pH measurements that were within the New Hampshire surface water quality standard (Figure 5).

Lower pH measurements are likely the result of natural conditions such as the soils, geology, or the presence of wetlands in the area. Rain and snow falling in New Hampshire is relatively acidic, which can also affect pH levels; after the spring melt or significant rain events, surface waters will generally have a lower pH.

Figure 5. pH Statistics for the Hodgson Brook Watershed
May 22 - October 7, 2005, NHDES VRAP

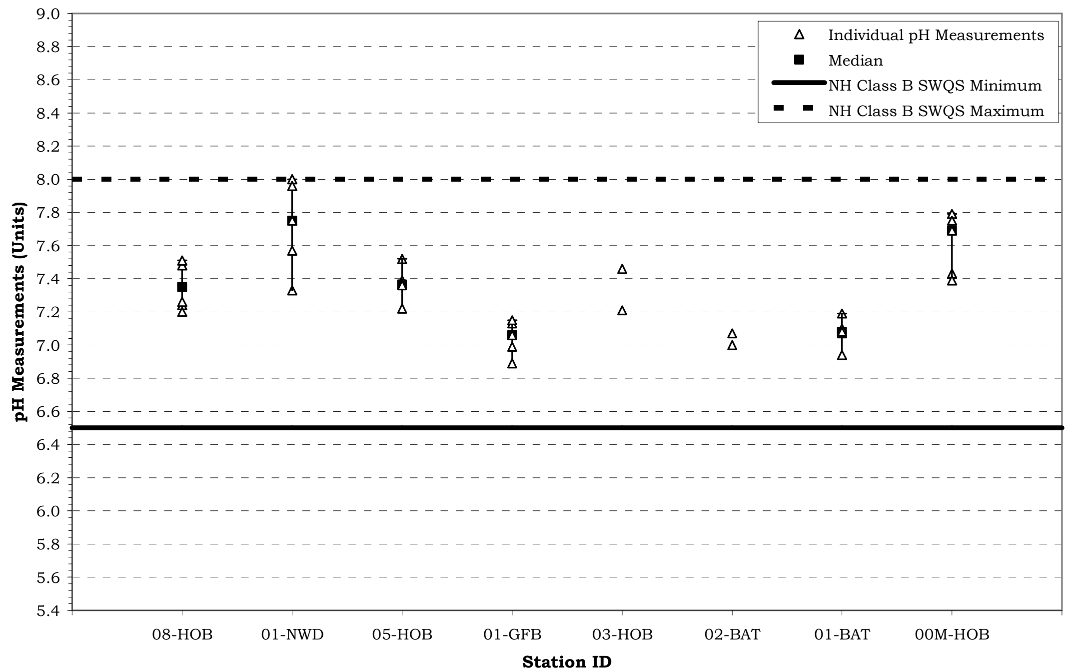
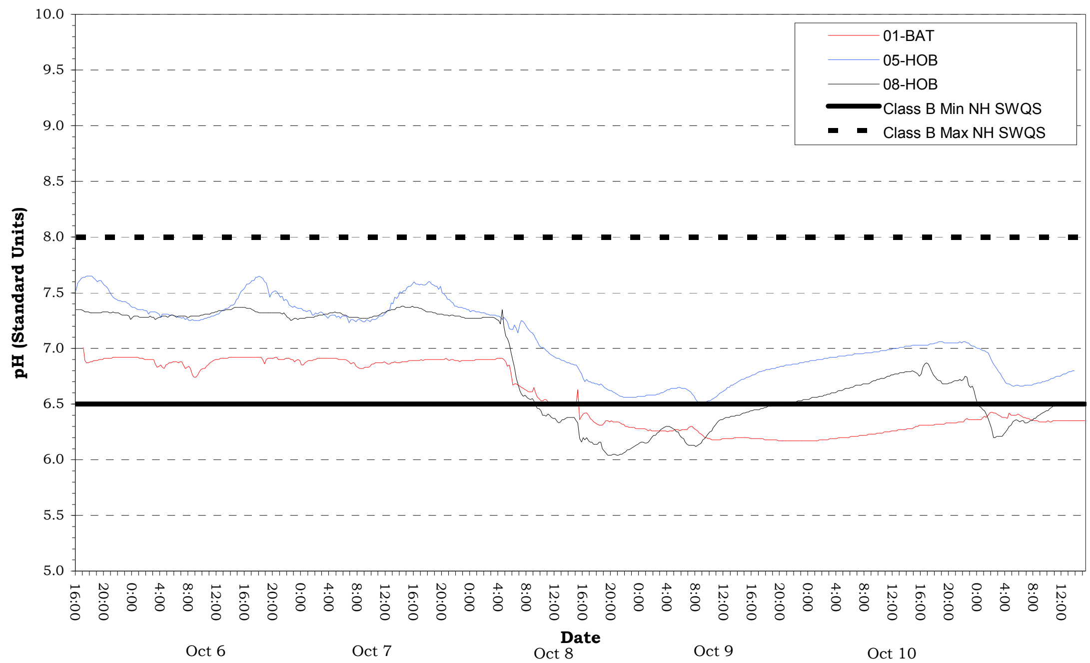


Figure 6 illustrates the results of pH measurements obtained at three stations in the Hodgson Brook watershed using submersible dataloggers. The meters were programmed to take pH readings every 15 minutes over a three-day period. During this deployment five full 24-hour periods were measured. In general the daily minimum pH is used to determine if the waterbodies are meeting surface water quality standards.

The pH measurements at all three stations were within the water quality standard on all occasions until early morning on October 8th. This coincides with the beginning of a period of significant precipitation. Rain and snow falling in New Hampshire is relatively acidic and after significant rain events, surface waters will generally have a lower pH.

Excluding the influence of rainfall, the pH measurement see in the Hodgson Brook watershed during 2005 are higher than the average pH values typical of other rivers and streams in the coastal watershed. The large variation in dissolved oxygen levels described in the previous section are likely contributing to higher pH levels. During daylight hours when all plants and algae are in an active state of photosynthesis, they absorb carbon dioxide from the water and use the sun's energy to convert it to simple organic compounds. Carbon dioxide in solution is acidic so as plants remove it the water becomes more alkaline. Thus, a higher density plants and/or algae and more sunshine reaching the surface water can lead to higher pH values.

Figure 6. pH Statistics for the Hodgdon Brook Watershed
October 5 - 11, 2005, NHDES VRAP



Recommendations

- ❖ Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

- ❖ Consider sampling for pH in some of the wetland areas that may be influencing the pH of stations with measurements below state standards. Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

4.3. Turbidity

Between two and five measurements were taken in the field for turbidity at eight stations in the Hodgson Brook watershed [Table 6]. Of the 33 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency. The Class B New Hampshire surface water quality standard for turbidity is less than 10 NTU above background.

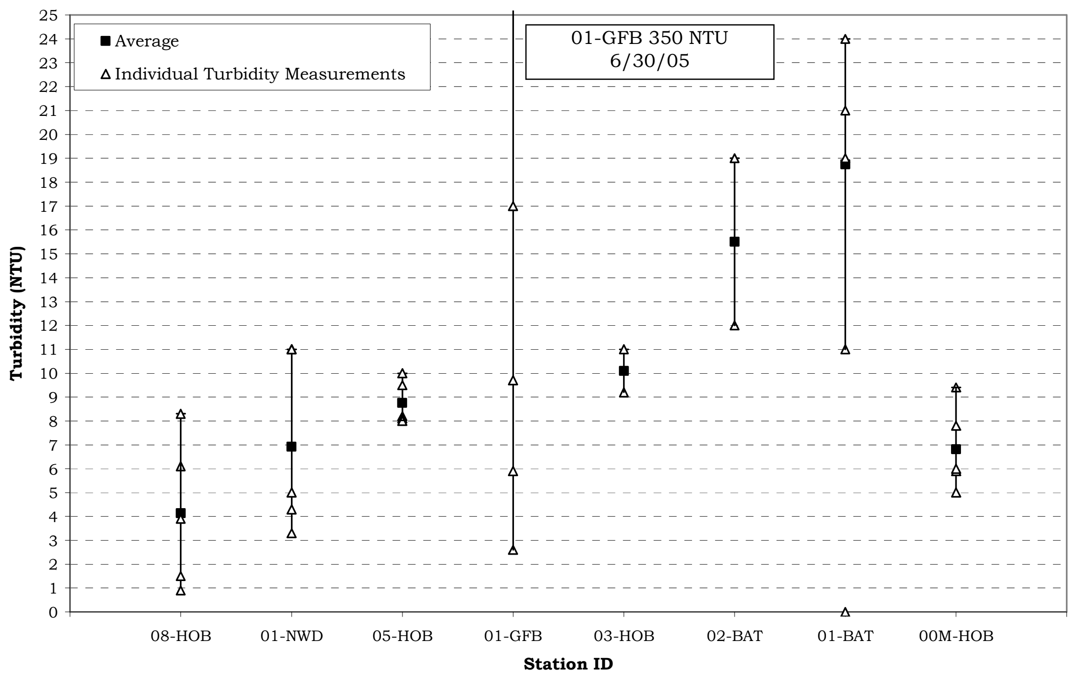
Table 6. Turbidity Data Summary – Hodgson Brook Watershed, 2005

Station ID	Samples Collected	Data Range (NTU)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
08-HOB	5	0.9 - 8.3	0	5
01-NWD	5	3.3 - 11.0	0	5
05-HOB	5	8 - 10	0	5
01-GFB	5	2.6 - 350.0	1	5
03-HOB	2	9.2 - 11.0	0	2
02-BAT	2	12.0 - 19.0	0	2
01-BAT	4	11.0 - 24.0	0	4
00M-HOB	5	5.0 - 9.4	0	5
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**33**

Turbidity levels were variable with the average ranging from 4.0 NTU to 77 NTU (Figure 7). The high average of 77 NTU at station 01-GFB is due to a single sample with a high value of 350 NTU recorded on 6/30/05. The National Weather Service recorded 0.5 inches of rain in Portsmouth on June 29th. However, given that none of the other stations monitored on June 30th saw a significant increase in turbidity it is unlikely that precipitation was the sole factor contributing to the high reading at 01-GFB .

Although clean waters are associated with low turbidity there is a high degree of natural variability involved. Precipitation often contributes to increased turbidity by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters. However, human activities such as removal of vegetation near surface waters and disruption of nearby soils can lead to dramatic increases in turbidity levels. In general it is typical to see a rise in turbidity in more developed areas due to increased runoff.

Figure 7. Turbidity Statistics for the Hodgson Brook Watershed
May 22 - October 7, 2005, NHDES VRAP



Recommendations

- ❖ Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.
- ❖ Collect samples during wet weather. This will help us to understand how the river responds to runoff and sedimentation.
- ❖ If a higher than normal turbidity measurement occurs, volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated turbidity levels. In addition, take good field notes and photographs. If human activity is suspected or verified as the source of elevated turbidity levels volunteers should contact NHDES.

4.4. Specific Conductance

Between two and six measurements were taken in the field for specific conductance at eight stations in the Hodgson Brook watershed [Table 7]. Of the 36 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency. VRAP staff also deployed submersible dataloggers to record specific conductance at three stations in the Hodgson Brook watershed.

New Hampshire surface water quality standards do not contain numeric limits for specific conductance.

Table 7. Specific Conductance Data Summary – Hodgson Brook Watershed, 2005

Station ID	Samples Collected	Data Range (µS/cm)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
08-HOB	6	407 - 1182	Not Applicable	6
01-NWD	5	318 - 741	N/A	5
05-HOB	6	492 - 1037	N/A	6
01-GFB	5	531 - 843	N/A	5
03-HOB	2	786 - 917	N/A	2
02-BAT	2	1378 - 1736	N/A	2
01-BAT	5	1389 - 2294	N/A	5
00M-HOB	5	715 - 1190	N/A	5
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**36**

Specific conductance levels were variable and relatively high at all stations with the average ranging from 627 µS/cm to 1863 µS/cm (Figure 8). Higher specific conductance levels can be indicative of pollution from sources such as urban/agricultural runoff, road salt, failed septic systems, or groundwater pollution. Thus, the higher specific conductance levels in the Hodgson Brook watershed generally indicate higher pollutant levels.

Figure 8. Specific Conductance Statistics for the Hodgson Brook Watershed
May 22 - October 7, 2005, NHDES VRAP

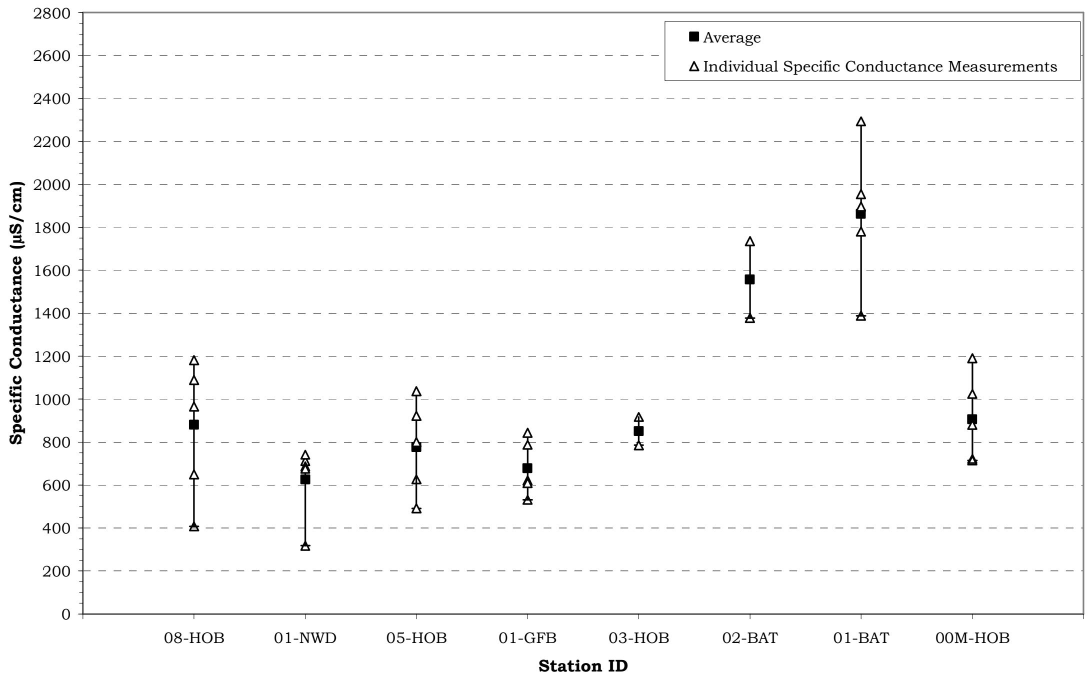
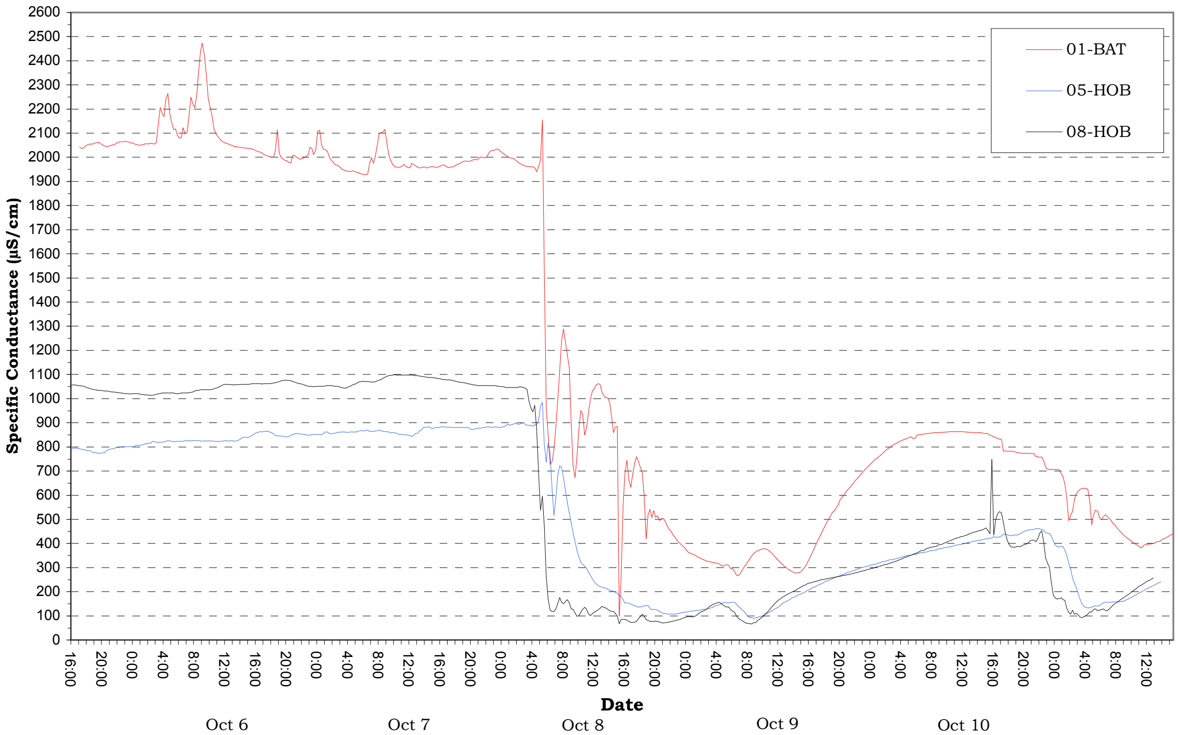


Figure 9 illustrates the results of specific conductance measurements obtained at three stations in the Hodgson Brook watershed using submersible dataloggers. The meters were programmed to take specific conductance readings every 15 minutes over a three-day period. During this deployment five full 24-hour periods were measured.

Figure 9. Specific Conductance Statistics for the Hodgdson Brook Watershed
October 5 - 11, 2005, NHDES VRAP



Specific conductance measurements at all three stations were relatively high until early morning on October 8th. This coincides with the beginning of a period of significant precipitation. The precipitous drop in specific conductance levels indicates rainwater was significantly contributing to the volume of water at each station. The rainwater had a much lower concentration of cations and anions than the baseflow in the Hodgson Brook watershed. As rainwater began to flow out of the watershed the specific conductance levels began to rise again.

Recommendations

- ❖ Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.
- ❖ Continue collecting chloride samples at the same time specific conductance is measured. During the late winter/early spring snowmelt, higher conductivity levels are often seen due to elevated concentrations of chloride in the runoff. Conductivity levels are often very closely correlated to chloride levels. Simultaneously measuring chloride and conductivity will allow for a better understanding of their relationship.

4.5. Chloride

Between one and three samples for chloride were collected at eight stations in the Hodgson Brook watershed [Table 8]. Of the 17 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency.

The Class B New Hampshire surface water quality standard for chloride is as follows:

Freshwater chronic criterion	230 mg/l
Freshwater acute criterion	860 mg/l

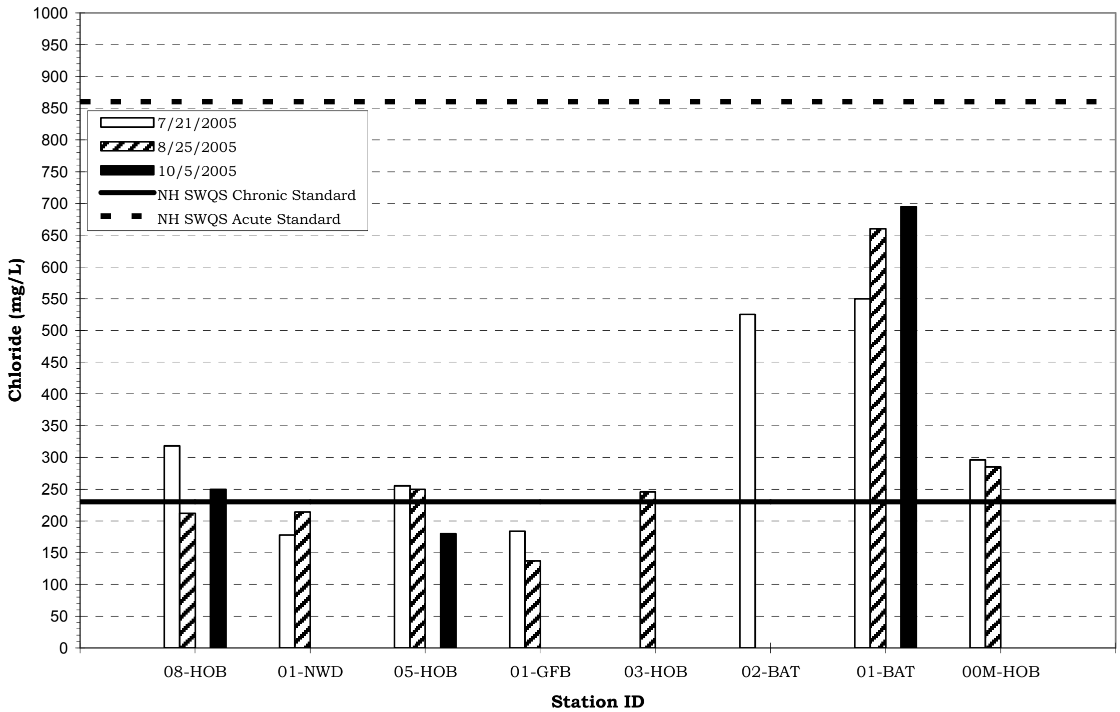
Table 8. Chloride Data Summary – Hodgson Brook Watershed, 2005

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting Chronic Standard	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
08-HOB	3	212 - 318	2	3
01-NWD	2	178 - 214	0	2
05-HOB	3	180 - 255	0	3
01-GFB	2	137 - 184	0	2
03-HOB	1	246	1	1
02-BAT	1	525	1	1
01-BAT	3	550 - 695	3	3
00M-HOB	2	285 - 296	2	2
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**17**

Chloride concentrations were above the chronic Class B surface water quality standard at five of the stations sampled. Although chloride can originate from natural sources, most of the chloride that enters the environment is associated with the storage and application of road salt. Road salt readily dissolves and enters aquatic environments in ionic forms. As such, chloride-containing compounds commonly enter surface water, soil, and groundwater during late-spring snowmelt (since the ground is frozen during much of the late winter and early spring). Chloride ions are conservative, which means they are not degraded in the environment and tend to remain in solution, once dissolved. Chloride ions that enter ground water can ultimately be expected to reach surface water and, therefore, influence aquatic environments and humans.

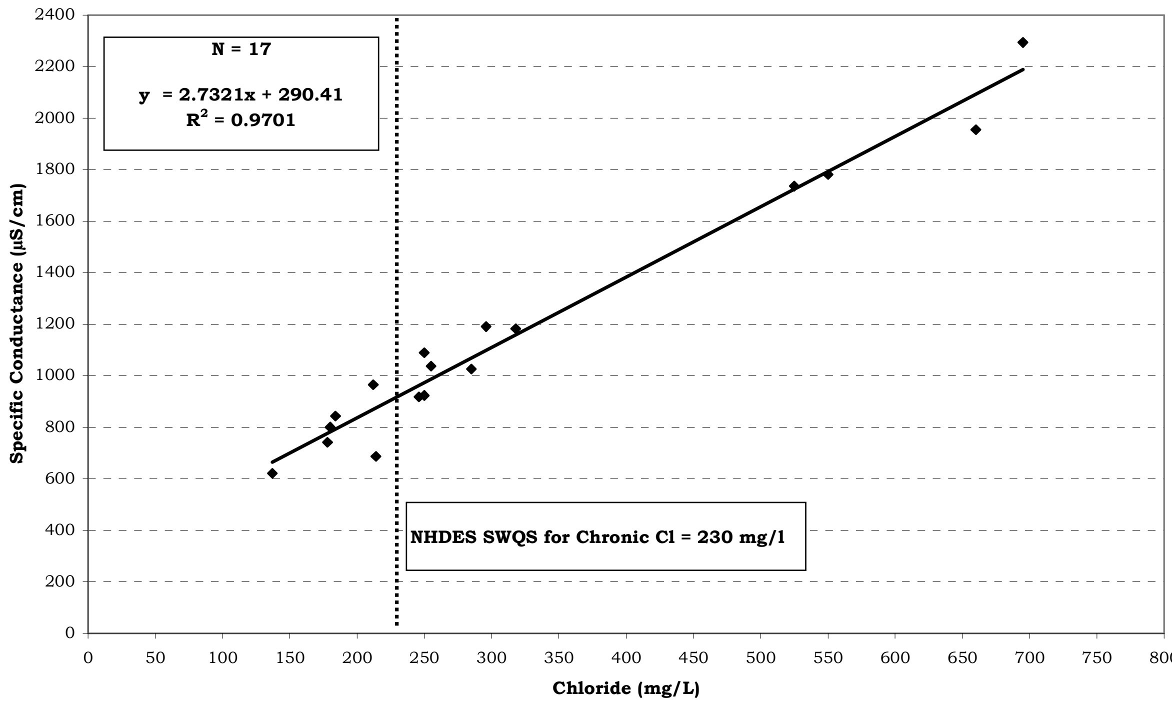
Additional human sources of chloride can come from fertilizers, septic systems, and underground water softening systems.

Figure 10. Chloride Statistics for the Hodgson Brook Watershed
July 21 to October 5, 2005 NHDES VRAP



Due to high specific conductance levels measured in the Hodgson Brook watershed during the first two rounds of sampling in 2005, VRAP staff requested that chloride samples be collected at the same time specific conductance was measured. Specific conductance levels can be closely correlated with chloride levels. Figure 5-8 depicts a regression model between chloride concentrations and specific conductance levels from the data collected in the Hodgson Brook watershed during 2005. Although the dataset only comprised 17 samples, the regression model shows a very close relationship between chloride levels and specific conductance levels (R^2 value = 0.97). This would indicate that higher chloride concentrations would be closely correlated with higher specific conductance levels. This correlation is consistent with additional studies being conducted by NHDES. This correlation is also valuable in showing at what approximate specific conductance value the chronic chloride standard is reached. The data collected in 2005 indicates that the 230 mg/L chloride standard is correlated with a specific conductance level of approximately 900 µS/cm.

Figure 11. Regression Correlation between Specific Conductance and Chloride in the Hodgson Brook Watershed 2005 VRAP



Recommendations

- Target additional sampling to those periods when chloride levels are likely to be highest (snowmelt).

- Continue to take specific conductance measurements simultaneously with chloride samples.

4.6. *Escherichia coli*/Bacteria

Between two and seven samples were collected for *Escherichia coli* (*E. coli*) at eight stations in the Hodgson Brook watershed (Table 9) Of the 47 measurements taken, 45 met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency.

Class B NH surface water quality standards for *E.coli* are as follows:

<406 cts/100 ml, based on any single sample, or
<126 cts/100 ml, based on a geometric mean calculated from three samples collected within a 60-day period.

Table 9. *E.coli* Data Summary – Hodgson Brook Watershed, 2005

Station ID	Samples Collected	Data Range (cts/100ml)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
08-HOB	7	10 - 1130	2	7
01-NWD	7	80 - 2001	1	7
05-HOB	7	80 - 1990	1	6[a]
01-GFB	7	80 - 1570	1	7
03-HOB	2	130 - 830	1	2
02-BAT	4	90 - 200	0	4
01-BAT	6	60 - 1720	1	6
00M-HOB	7	30 - 1730	1	6[a]
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**45**

[a] 6/30/05 Samples to Numerous to Count (TNTC); Unable to determine E.coli levels

Seven stations on one occasion had a single sample level of *E.coli* which exceeded the New Hampshire surface water quality standard (Figure 12). Station 08-HOB exceeded the standard twice and 02-BAT had no samples that exceeded the standard. In order to fully determine whether a waterbody is meeting surface water standards for *E.coli* a geometric mean must be calculated. A geometric mean is calculated using three samples collected within a 60-day period. At seven stations geometric means were calculated and all seven stations had two or more geometric means that were above the standard of 126 cts/100ml (Table 10).

Several factors can contribute to elevated *E. coli* levels, including, but not limited to rain storms, low river flows, the presence of wildlife (e.g., birds), and the presence of septic systems along the river.

Figure 12. *Escherichia coli* Statistics for the Hodgson Brook Watershed
May 26 - August 15, 2005, NHDES VRAP

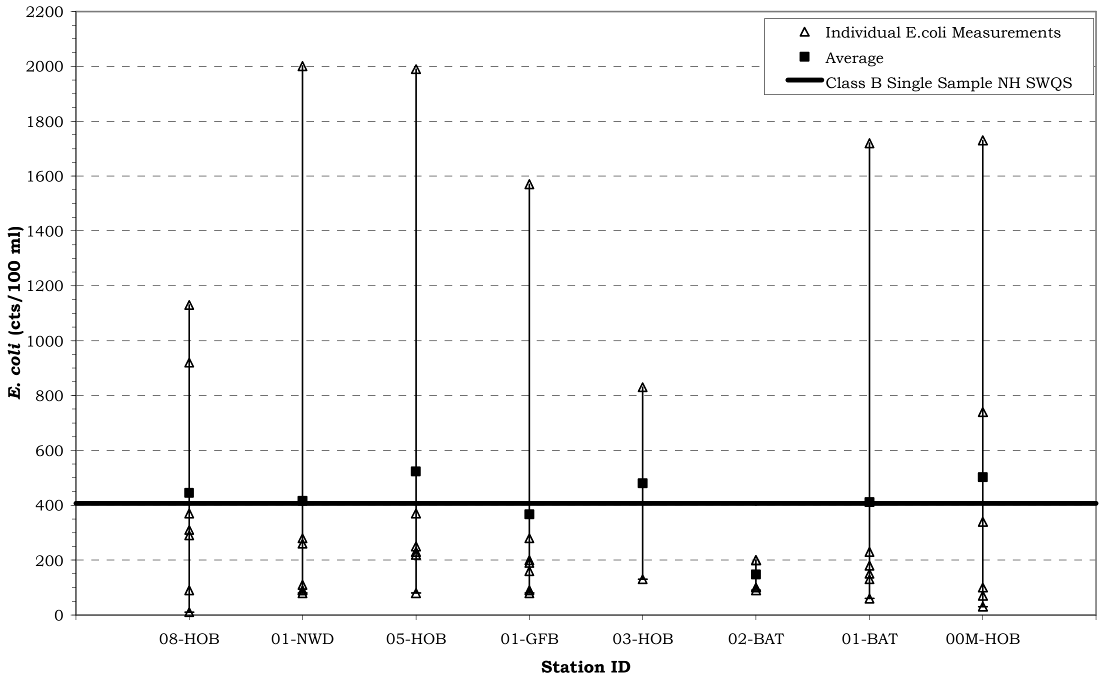


Table 9. *E. coli* Geometric Mean Data Summary – Hodgson Brook, 2005

Station ID	Geometric Means Calculated	Geometric Means Not Meeting NH Class A/B Standards	Number of Usable Geometric Means for 2006 NH Surface Water Quality Assessment
08-HOB	5	3	5
01-NWD	5	4	5
05-HOB	4	4	4
01-GFB	5	5	5
02-BAT	2	2	2
01-BAT	4	2	4
00M-HOB	4	3	4
Total Number of Useable Geometric Means for 2006 NH Surface Water Quality Assessment			**29**

Recommendations

- Continue collecting three samples within any 60-day period during the summer to allow for determination of geometric means.

- Continue to document river conditions and station characteristics (including the presence of wildlife in the area during sampling).

- At stations with particularly high bacteria levels volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated bacteria levels. Those sampling should also look for any potential sources of bacteria such as emission pipes and failed septic systems.

APPENDIX A

2005 Hodgson Brook Watershed Water Quality Data

APPENDIX B

Interpreting VRAP Water Quality Parameters

APPENDIX C

Glossary of River Ecology Terms